

CA
1
P660
84
N13
CA 1 EP66084N13

Earth Sciences Library

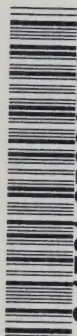


**Environment
Canada**

**Environnement
Canada**

**National
Water
Research
Institute**

**Institut
National de
Recherche sur les
Eaux**



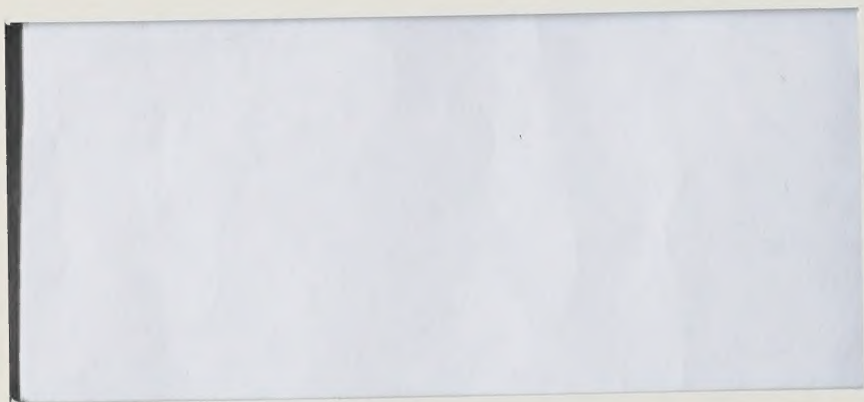
3 1761 05686522 3

Incidence of Legionella Organisms in
Canadian Environmental Waters and Water
Distribution Systems 1983-84 studies

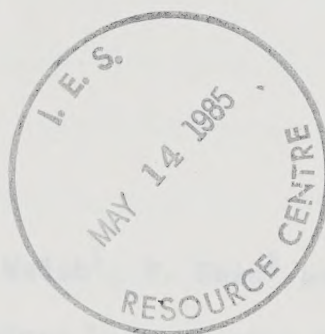
B.J. Dutka, K. Walsh, P. Ewan and R.S. Tobin

**Inland Waters
Directorate**

**Direction Générale
des Eaux Intérieures**



NWRI CONTRIBUTION NO. 84-13



Incidence of Legionella Organisms in
Canadian Environmental Waters and Water
Distribution Systems 1983-84 studies

B.J. Dutka, K. Walsh, P. Ewan and R.S. Tobin

NWRI Contribution 84-13

**INCIDENCE OF LEGIONELLA ORGANISMS IN CANADIAN
ENVIRONMENTAL WATERS AND WATER DISTRIBUTION SYSTEMS,
1983-84 STUDIES**

B.J. Dutka¹, K. Walsh¹, P. Ewan² and R.S. Tobin³

¹Microbiology Laboratories Section
Analytical Methods Division
National Water Research Institute
Burlington, Ontario L7R 4A6

²Special Reference Bacteriology
Bureau of Microbiology
Health Protection Branch
Health and Welfare Canada
Ottawa, Ontario K1A 0L2

³Microbiology Advisor
Monitoring and Criteria Division
Health Protection Branch
Health and Welfare Canada
Ottawa, Ontario K1A 0L2



Digitized by the Internet Archive
in 2025 with funding from
University of Toronto

<https://archive.org/details/31761056865223>

ABSTRACT

The national survey for the presence of Legionella organisms in natural waters as well as potable water supplies and cooling towers was continued in 1983. This report details information on the three Canadian Maritime provinces, Lake Superior and from buildings' water supplies sampled in the following cities: Vancouver, Edmonton, Calgary, Poplar River, Regina, Winnipeg, St. Catharines, Mississauga, Ottawa, Montreal, Quebec City, Fredericton and Halifax. Three different sampling sites on Lake Superior were positive for Legionella organisms and positive Legionella isolations were obtained from the following city water samples: Vancouver, Calgary, Regina, St. Catharines, Mississauga, Ottawa, Montreal and Halifax. Methodology problems and implications of these results are discussed.

The national survey for the presence of Legionella organisms in natural waters as well as potable water supplies and cooling towers was completed in 1971. This survey results demonstrated that the highest number of positive results were obtained from Ontario, where positive results in the drinking water, swimming pools, hot water, and cooling towers, together with other water supplies, in Ontario, Manitoba, Alberta, Saskatchewan, and British Columbia. Positive results were also obtained from the following provinces and territories: Yukon, Northwest Territories, Nunavut, and the Northwest Territories. Positive results were also obtained from the following provinces and territories: Yukon, Northwest Territories, Nunavut, and the Northwest Territories. Positive results were also obtained from the following provinces and territories: Yukon, Northwest Territories, Nunavut, and the Northwest Territories.

INTRODUCTION

In the fall of 1981 a preliminary survey was carried out by Microbiological Laboratories staff, on the Canadian Great Lakes (Dutka and Ewan 1983) to find out whether or not Legionella organisms were present in these waters. Based on the results of this preliminary study in which Legionella organisms were isolated from waters at two of the 52 sampling sites (Georgian Bay and Lake St. Clair), it was decided to launch a national survey on the distribution patterns of Legionella organisms in Canadian natural waters. Therefore, to this end in 1982, 221 one litre water samples were collected from Lake Ontario and Ontario and Quebec lakes and rivers and an additional 129 samples from 31 commercial, public and private buildings in Central Ontario (Dutka et al., 1983). The 31 buildings were sampled under the belief that if Legionella organisms are present in relatively pure Great Lakes waters, they may also be present in potable water sources and thence into distribution lines and cooling towers in public and commercial buildings. Approximately one-half of the Lake Ontario samples were collected offshore and most of the inland lake and river samples were inshore samples taken near the water surface.

In 1983 this national survey continued with samples being collected from Lake Superior (25 sampling sites), the rivers and lakes of the Canadian provinces of New Brunswick (23 sites), Nova Scotia

(25 sites), Prince Edward Island (15 sites) and Eastern Quebec (3 sites) as well as water distribution lines and cooling tower waters from buildings in the following cities: Vancouver, Edmonton, Calgary, Popular River (Saskatchewan), Regina, Winnipeg, St. Catharines, Mississauga, Ottawa, Montreal, Quebec City, Fredericton and Halifax.

This report describes the findings of the 1983 portion of the National Legionella Study as well as reviewing 1981 and 1982 data.

METHODS

Sampling Sites

Two litre surface water samples were collected for the Legionella incidence study on four routine surveillance cruises on Lake Superior during the following time periods in 1983: May 17 to 28, June 23 to July 2, September 1 to 10, October 16 to 25 (Figure 1). These samples were refrigerated at 4°C until they could be processed. Similarly two litre samples were collected from rivers and lakes in the Maritime provinces of New Brunswick, Nova Scotia, Prince Edward Island and eastern Quebec (Figure 2). All of these samples had temperature and pH determined upon collection and selected samples were also tested for heterotrophic bacterial densities, streptomyces densities, total microbial densities and INT-formazon reducing populations.

Two buildings, one in Mississauga and the other in St. Catharines, which had been found to have Legionella organisms in their water distribution systems during the 1982 study (Dutka et al., 1983) were resampled five times during the July to September period, 1983. On a one time basis, two to three buildings were sampled in the following cities and these were the usual sampling sites: potable water, hot water, shower and cooling tower in Vancouver, Edmonton,

Calgary, Popular River (Saskatchewan), Regina, Winnipeg, Ottawa, Montreal, Quebec City, Fredericton and Halifax. All water samples collected from buildings had the following parameters also tested: temperature, pH, alkalinity, conductivity and free and total chlorine.

Bacteriological Tests

All water samples collected for Legionella isolation and enumeration were treated thusly; one or two litres of the sample was filtered through 0.45 μm (Lake Superior and drinking water), 0.8 μm (cooling tower samples) and 0.6 μm (the remainder of the samples) polycarbonate membrane filters (where turbidity was great, up to four membrane filters were occasionally required, with two being the usual case). The membranes were then placed one face down and the second face up (to ensure that the bacteria could be easily dislodged in the sonication process) in 10 mL boiled tap water in 100 mL sterile capped ointment jars. Where four membranes were required, these were placed as noted above in two jars with 5 mL boiled tap water per jar.

The ointment jars were then placed in a sonic sink for 10 minutes to dislodge the bacteria from the surface of the membrane filter and into the water. Then portions of the sonicated sample were removed and acidified with a pH 2 solution containing 0.2 M HCl and

0.2 M KCl. After 10 minutes the sample was neutralized to pH 6.9 and 0.5 to 1.0 mL aliquots were plated on buffered charcoal yeast extract agar with (CCVC) (Bopp et al., 1981) and without (CCVC-) the addition of cephalothin, colistin, vancomycin and cyclohexamide; glycine vancomycin-polymyxin B (GVP) agar (Wadowsky and Yee 1981) and CCVC agar with the addition of 20 µg/mL $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ (CCVC+) as recommended by Tesh and Miller (1982).

The agar plates were incubated for five days at 37°C. All suspected Legionella colonies were streaked onto CCVC and nutrient agar plates and incubated at 20°C and 37°C for three days. Only colonies appearing on CCVC agar incubated at 37°C and not on any other plates were subjected to confirmation tests as Legionella spp. on the basis of growth, biochemical and immunological characteristics (Feeley and Gorman, 1980).

At selected sites in the Maritime provinces survey, the following additional microbiological tests were performed: heterotrophic plate count densities using spread plate procedures (Dutka 1978); total microbial densities using acridine orange fluorescent microscopy techniques (Rao et al., 1981); total respiring microbial population as estimated by the INT-formazon reduction microscopic technique (Rao et al., 1984); and Streptomyces population using membrane filtration procedures and incubation for seven days at 20°C

0.5 to 1.0. After 10 minutes the sample was transferred to the 400 ml
beaker and placed in a boiling water bath. The solution
was then cooled and the solid material was removed by filtration.
The filtrate was then concentrated under reduced pressure and the
solid material was dried in a vacuum oven at 40°C for 24 hours.
The solid material was then ground to a fine powder and stored in a
desiccator until used.

The solid material was then ground to a fine powder and stored in a
desiccator until used. The solid material was then ground to a fine
powder and stored in a desiccator until used. The solid material was
then ground to a fine powder and stored in a desiccator until used.
The solid material was then ground to a fine powder and stored in a
desiccator until used. The solid material was then ground to a fine
powder and stored in a desiccator until used. The solid material was
then ground to a fine powder and stored in a desiccator until used.
The solid material was then ground to a fine powder and stored in a
desiccator until used.

As indicated above in the literature, the solid material was
ground to a fine powder and stored in a desiccator until used.
The solid material was then ground to a fine powder and stored in a
desiccator until used. The solid material was then ground to a fine
powder and stored in a desiccator until used. The solid material was
then ground to a fine powder and stored in a desiccator until used.
The solid material was then ground to a fine powder and stored in a
desiccator until used. The solid material was then ground to a fine
powder and stored in a desiccator until used. The solid material was
then ground to a fine powder and stored in a desiccator until used.
The solid material was then ground to a fine powder and stored in a
desiccator until used.

RESULTS

Figure 1 shows the location of the 25 sampling stations in Lake Superior which were sampled during the four 1983 Lake Superior surveillance cruises carried out by National Water Research Institute staff. Legionella organisms were isolated on three of the cruises at the following sites: #187, northeast of Ashland, Wisconsin (June); #50, northeast of Munsing, Michigan, (September), and #135, at the mouth of Black Bay east of Sibley Provincial Park (November).

Also shown in Figure 1 are the other sampling sites from which Legionella organisms were isolated on previous studies, (a) between Wolfe and Amherst Islands off Kingston in Lake Ontario (July 1982), (b) Toronto Harbour, surface and 14 metre depth samples (July and November 1982), (c) Lake St. Clair (September 1981) and (d) Georgian Bay (September 1981).

The concentrations of Legionella organisms isolated during these studies and the medium from which they were isolated are shown below.

SECRET

Figure 1 shows the location of the 12 sampling stations in Lake Superior which were sampled during the June 1955 Lake Superior surveillance cruise. The 12 stations were located as follows: (1) near the mouth of Lake Superior, (2) near the mouth of Lake Superior, (3) near the mouth of Lake Superior, (4) near the mouth of Lake Superior, (5) near the mouth of Lake Superior, (6) near the mouth of Lake Superior, (7) near the mouth of Lake Superior, (8) near the mouth of Lake Superior, (9) near the mouth of Lake Superior, (10) near the mouth of Lake Superior, (11) near the mouth of Lake Superior, (12) near the mouth of Lake Superior.

Also shown in Figure 1 are the other sampling stations which were sampled during the June 1955 Lake Superior surveillance cruise. The 12 stations were located as follows: (1) near the mouth of Lake Superior, (2) near the mouth of Lake Superior, (3) near the mouth of Lake Superior, (4) near the mouth of Lake Superior, (5) near the mouth of Lake Superior, (6) near the mouth of Lake Superior, (7) near the mouth of Lake Superior, (8) near the mouth of Lake Superior, (9) near the mouth of Lake Superior, (10) near the mouth of Lake Superior, (11) near the mouth of Lake Superior, (12) near the mouth of Lake Superior.

The concentration of hydrocarbons in the water samples and the water from the 12 stations are shown in Figure 2.

Sampling Site	Organism	Media and Concentration of <u>Legionella</u> /L			
		CCVC	CCVC-	CCVC+	GVP
L. Superior #187	<u>L. pneumophila</u> ⁽¹⁾	30	0	270	120
L. Superior #50	<u>L. pneumophila</u> Serogroup 1	30	0	0	0
L. Superior #135	<u>L. pneumophila</u> Serogroup 6	0	30	0	0
L. Ont. Kingston area	<u>L. pneumophila</u> Serogroup 1	0	NT*	NT*	60
L. Ont. Toronto Harbour 1 m	<u>L. pneumophila</u> Serogroup 5	0	NT	NT	250
L. Ont. Toronto Harbour 14 m	<u>L. pneumophila</u> Serogroup 6	60	NT	NT	0
Georgian Bay	<u>L. pneumophila</u> Serogroup 6	250	NT	NT	0
L. St. Clair	<u>L. pneumophila</u> Serogroup 6	600	NT	NT	0

*NT = not tested

(1) Organism lost before final serotyping could be completed.

The 66 samples collected from the three Maritime provinces and eastern Quebec all proved to be negative for Legionella organisms by the isolation and enumeration technique used. However, during this study at selected stations some other bacteriological baseline data were collected in hopes of correlating positive and negative Legionella isolations with various bacteriological parameters. These data, for reference only, are presented in Table 2.

The repeated sampling of four sites within a Mississauga and St. Catharines, Ontario building, confirmed 1982 studies (Dutka et al., 1983) which showed the presence of Legionella organisms in these buildings. Only two samples were positive for Legionella in the Mississauga building, both from the cooling tower sump, one collected in August and the other in September. The organism isolated from these cooling tower water samples was L. pneumophila, serogroup 6, the same serogroup isolated during the 1982 study. At the St. Catharines site an unusual feature was noted in that all five samples collected from a cold water tap over a three-month period were found to contain L. pneumophila, serogroup 1. Two of the cooling tower water samples were also positive for L. pneumophila, serogroup 1, while a shower sample produced a L. pneumophila with serogroup 1-3 reaction.

In the cross-Canada building survey, shown in Table 1, it can be seen that Legionella organisms were isolated from buildings in Ottawa, Montreal, Halifax, Regina, Calgary and Vancouver. The majority of the positive isolations were made from cooling tower samples. The only other sampling sites positive for Legionella were shower facilities in Regina and Ottawa. In this study, Legionella isolations were made from waters with free chlorine residuals varying from 0.1 to 6.0 mg/L, pH values varying from 6.3 to 8.92 and water temperatures from 15°C to 41°C.

The concentration of Legionella organisms, their identification and the media from which they were recovered in the cross-Canada study are presented in Table 3. In this table it can be seen that organism concentration varied from 30/L to 45,000/L (shower). In trying to recognize which medium and media combination produced the greatest number of Legionella isolations, it was found that GVP (12) and CCVC+ (11) were the most productive single media; and when the following three media combinations were compared, CCVC and CCVC+, CCVC and GVP, and CCVC+ and GVP, it was found that CCVC+ and GVP media combination produced 18 of the 19 isolations, CCVC and GVP produced 15 of the 19 isolations and the combination of CCVC and CCVC+ only produced 12 positive Legionella isolations.

Table 4 displays the typical antibiotic sensitivity patterns shown by the various Legionella isolates. In some samples, two morphologically different colonies of the same serotype were tested, and these colonies were found to produce different antibiotic sensitivity patterns, most notably in their response to penicillin: Regina 9A sample, Mississauga cooling tower sample and Calgary 10B sample. The only consistent antibiotic response pattern was complete resistance of all Legionella organisms tested to Colistin sulphate. Only one organism was found to be completely resistant to Clindomycin (10 µg), and four organisms were found to be resistant to penicillin G (10 µg).

DISCUSSION

The results of the 1983 environmental and cross-Canada city survey confirm 1982 study results which indicated that Legionella organisms are not highly predominant in Canadian waters. Out of 100 water samples collected from Lake Superior only three samples were positive for Legionella and the concentrations did not exceed 270 organisms per litre. The survey data from the Maritime provinces lakes and rivers would suggest that Legionella organisms are not a major or even a minor part of the aquatic flora, as 1 mL of water sample usually contains 10^6 organisms, in contrast to positive findings of Legionella at the rate of 0.27 organisms per mL (Lake Superior also has a total microbial population of approximately 10^5 organisms per mL).

The Maritime data are strongly confirmatory of the Ontario and Quebec river and lake study carried out in 1982, which found only one site positive for Legionella (Blind River) out of 112 samples.

Nevertheless, the authors of this report believe that Legionella organisms are present in some or many of the environmental waters tested, but at levels which are not detectable by the techniques used. The culturing techniques used are not able to completely suppress background growth which in many instances, at the suspected

Legionella concentration present, overgrows the agar plates and when dilutions are made to solve the overgrowth problem the few Legionella organisms which might be there are diluted out. Thus in most instances, the finding of Legionella organisms in a water sample is like trying to find a needle in a haystack; you know it is there, but where.

Other important factors which play a role in Legionella isolation are the stresses on the organism due to membrane filtration, sonic sink and acid treatments. In a previous study by Dutka et al., (1983), it was reported that in pure culture studies, often only 10% or less of the potential population was isolated when the organisms were subjected to membrane filtration, sonic sink and acid treatment stresses. Thus background flora plus isolation technique stresses are believed to be responsible for the paucity of positive isolations of Legionella organisms from environmental samples. Notwithstanding the foregoing, the results of this study also strongly support the concept that Legionella organisms, when present in natural waters, form only a very minor fraction of the microbial flora.

Another reason for the belief that Legionella organisms, although often undetected, form a small but perhaps consistent proportion of the natural aquatic flora, is the finding of Legionella organisms in potable water distribution systems and cooling tower

waters (which usually are fed from potable water distribution lines) in cities all across Canada. The only obvious common source of these organisms, based on the known environmental niche of Legionella organisms, is the fresh water supply source for these cities, which in most cases are rivers and lakes.

The data from this study and the philosophy we hold regarding the sources of Legionella found in water distribution lines (Dutka et al., 1983) are still in agreement with and more strongly support the thesis of Dufour and Jakubowski (1982) who concluded that the main source of Legionella spp. contamination is the environment, where they may be present at low (or sometimes high) levels. It is probable that Legionella contamination of potable water supplies by this organism occurs through its occasional passage through the water treatment plant. However, it is only when conditions are favourable for their proliferation that populations increase and massive contamination occurs. Such factors may include biofilms, temperature, oxygen concentrations, complementary mix of inorganic and organic chemicals, presence of symbiotic organisms, fluid velocity and turbulence and many number of yet known factors (Sharpe 1982).

In the 1983 Lake Superior studies, L. pneumophila serogroups 1 and 6 were isolated along with one unknown L. pneumophila serogroup (which was lost before serotyping would be completed). Serogroups 1

and 6 were also found in earlier Great Lakes studies with serogroup 6 being the most prevalent isolate in these studies. Thus, in the three-year survey of the Canadian Great Lakes for Legionella organisms, three L. pneumophila serogroups have been isolated, 1, 5 and 6, and co-incidentally serogroups 1 and 6 appear to be predominant in cooling tower and potable water distribution lines in southern Ontario buildings (Dutka et al., 1983). These findings, we believe, are supportive of the hypothesis that the source of L. pneumophila in cooling tower and potable water lines are Legionella organisms that have survived the drinking water treatment processes and have settled in a supportive, less stressful and probably less competitive environment, within potable water and cooling tower water systems.

Legionella incidence data collected from water distribution lines in buildings sampled across Canada indicates that Legionella organisms can readily be found in water distribution lines and cooling tower waters. Furthermore, based on our 1982 (Dutka et al., 1983) and 1983 studies, L. pneumophila serogroup 6 appears to be one of the more widely distributed serogroups in Canadian waters. The isolation of L. dumoffii from a shower water in Regina was only the second time that we were able to isolate this organism. The first isolation occurred in 1982 from Blind River, Ontario.

Based on the frequency of isolation of Legionella organisms from water samples by the four media used (Table 3), it would appear that GVP (Wadowsky and Yee 1981) and CCVC+ media which contains 20 $\mu\text{g/mL}$ $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ as recommended by Tesh and Miller (1982) are the most efficient media for isolating Legionella organisms from water samples. Furthermore, the combination of GVP and CCVC+ media resulted in 18 of the 19 positive isolations of Legionella organisms. From these results it would appear prudent to use a two-media combination in all future studies, GVP and CCVC+.

based on the frequency of infection of *Legionella* organisms
from water samples by the four wells used (Table 1). It would appear
that the frequency and the illness and death rates were similar
to other reports. With no transmission in town and illness limited to the
most affluent areas the infection *Legionella* organisms from water
samples. Furthermore, the prevalence of the two strains was equal.
It is of note that the frequency of *Legionella* organisms from
these samples is about equal to that of a *Legionella* infection
in all these studies, 1970 and 1971.

REFERENCES

- Bopp, C.A., J.W. Summer, G.K. Morris and T.G. Wells 1981. Isolation of Legionella spp. from environmental water supplies by low pH treatment and use of a selective medium. J. Clin. Microbiol. 13:714-719.
- Dufour, A.P. and W. Jakubowski 1982. Drinking water and Legionnaires' Disease. J. Amer. Water Works Assoc. 74:631-637.
- Dutka, B.J. ed. 1978. Methods for microbiological analysis of waters, wastewaters and sediments. Dept. of Fisheries and Environment, IWD, CCIW, Burlington, Ontario, Canada.
- Dutka, B.J., K. Walsh, P. Ewan, A. El-Shaarawi and R.S. Tobin 1983. Environmental distribution patterns of Legionella in central Canada and longevity studies. Environment Canada, NWRI, IWD Inhouse Report #69-AMD-5-83-BJD.
- Dutka, B.J. and P. Ewan 1983. Isolation of Legionella pneumophila from the Canadian Great Lakes. J. Great Lakes Res. 9(3):430-432.

REFERENCES

Boyd, C.A., 1969. Survey of the fish of the Great Lake Basin.
at length and weight of the fish of the Great Lake Basin.
by length and weight of the fish of the Great Lake Basin.
at length and weight of the fish of the Great Lake Basin.

Boyd, C.A., 1970. Survey of the fish of the Great Lake Basin.
at length and weight of the fish of the Great Lake Basin.
by length and weight of the fish of the Great Lake Basin.
at length and weight of the fish of the Great Lake Basin.

Boyd, C.A., 1971. Survey of the fish of the Great Lake Basin.
at length and weight of the fish of the Great Lake Basin.
by length and weight of the fish of the Great Lake Basin.
at length and weight of the fish of the Great Lake Basin.

Boyd, C.A., 1972. Survey of the fish of the Great Lake Basin.
at length and weight of the fish of the Great Lake Basin.
by length and weight of the fish of the Great Lake Basin.
at length and weight of the fish of the Great Lake Basin.

Boyd, C.A., 1973. Survey of the fish of the Great Lake Basin.
at length and weight of the fish of the Great Lake Basin.
by length and weight of the fish of the Great Lake Basin.
at length and weight of the fish of the Great Lake Basin.

- Feeley, J.C. and G.W. Gorman 1980. Legionella. In E.H. Lennette, A. Balows, W.J. Hauslen Jr. and J.P. Truant (ed.), Manual of clinical microbiology, 3rd ed., ASM, Washington, DC, U.S.A.
- Rao, S.S., A.A. Jurkovic and B.J. Dutka 1981. Application de la technique de réduction du INT-FORMAZON et de l'orange d'acridine à l'estimation de l'activité bactérienne en eau douce. Eau du Quebec 14:234-236.
- Rao, S.S., A.A. Jurkovic and B.J. Dutka 1984. Some factors influencing the enumeration of metabolizing aquatic bacteria. Journal of Testing and Evaluation 12:56-59.
- Sharpe, V.J. 1982. Biofilm formation and control - a review. Ontario Hydro Research Division Report No. 82-252-K, Toronto, Ontario, Canada.
- Tesh, M.J. and R.M. Miller 1982. Growth of Legionella pneumophila in defined media: requirement for magnesium and potassium. Can. J. Microbiol. 28:1055-1058.
- Wadowsky, R.M. and R.B. Yee 1981. A glycine-containing selective medium for isolation of Legionellaceae from environmental specimens. Appl. Environ. Microbiol. 42, 768-778.

Wolfe, J.C. and G.W. Brown 1960. Geography. In F.H. Lewis, ed. Handbook of North American Indians, Vol. 1, General. Smithsonian Institution, Washington, D.C., U.S.A.

Wolfe, J.C., A.A. Johnston and G.W. Brown 1960. Geography. In F.H. Lewis, ed. Handbook of North American Indians, Vol. 1, General. Smithsonian Institution, Washington, D.C., U.S.A.

Wolfe, J.C., A.A. Johnston and G.W. Brown 1960. Geography. In F.H. Lewis, ed. Handbook of North American Indians, Vol. 1, General. Smithsonian Institution, Washington, D.C., U.S.A.

Wolfe, J.C., A.A. Johnston and G.W. Brown 1960. Geography. In F.H. Lewis, ed. Handbook of North American Indians, Vol. 1, General. Smithsonian Institution, Washington, D.C., U.S.A.

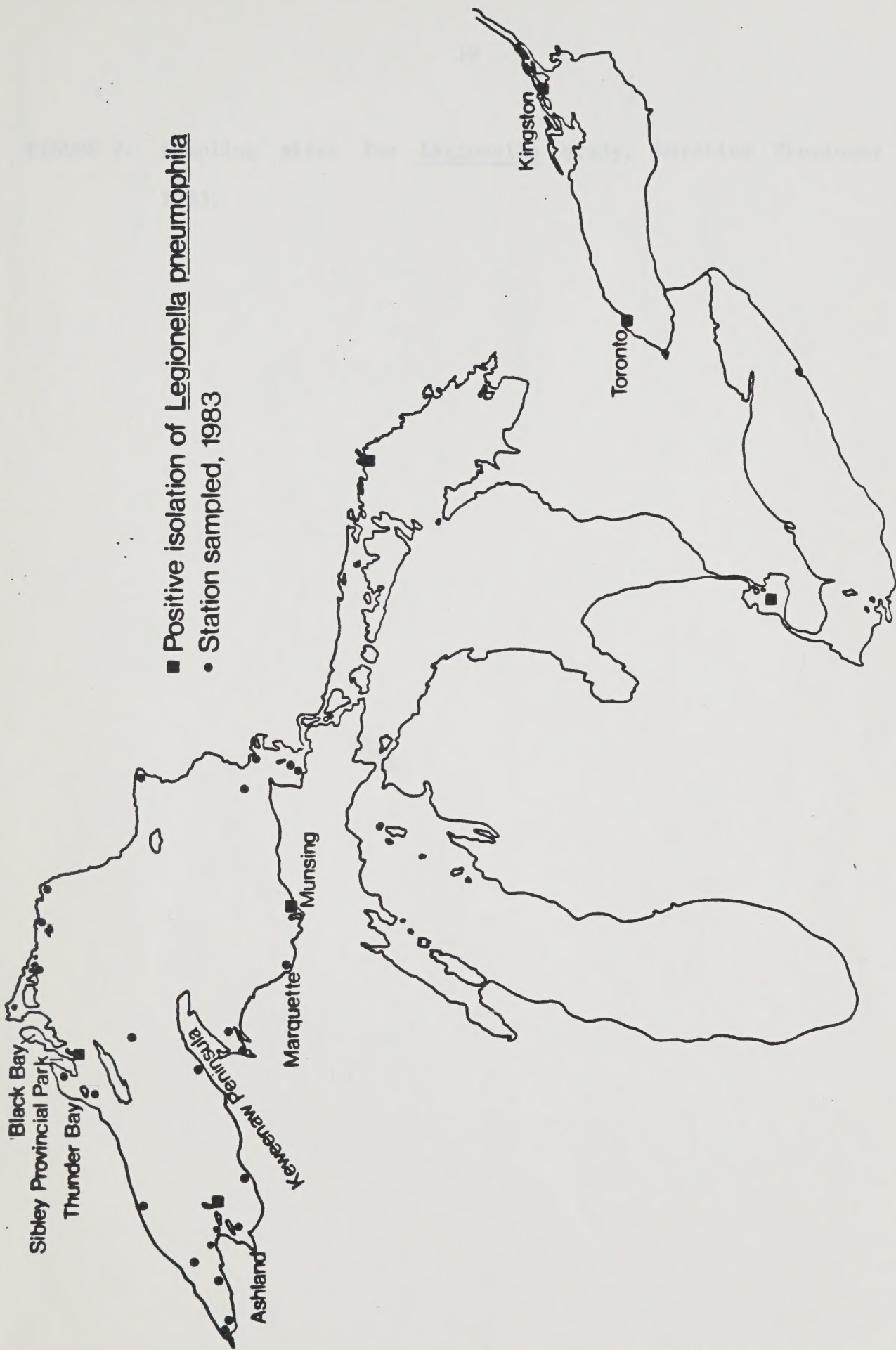
Wolfe, J.C., A.A. Johnston and G.W. Brown 1960. Geography. In F.H. Lewis, ed. Handbook of North American Indians, Vol. 1, General. Smithsonian Institution, Washington, D.C., U.S.A.

Wolfe, J.C., A.A. Johnston and G.W. Brown 1960. Geography. In F.H. Lewis, ed. Handbook of North American Indians, Vol. 1, General. Smithsonian Institution, Washington, D.C., U.S.A.

FIGURE 1. 1983 Lake Superior Legionella sampling sites and sites of positive isolations from previous Great Lakes studies.



FIGURE 1. 1981 Lake Superior *Salvelinus namaycush* (Lake Trout) and Whitefish
 Positive Correlation from 1970-1980 Lake Trout





Handwritten text, possibly a title or description, located in the upper right area of the map. The text is too faint to be transcribed accurately but appears to be a single line of writing.

Handwritten text, possibly a title or description, located in the lower right area of the map. The text is too faint to be transcribed accurately but appears to be a single line of writing.

FIGURE 2: Sampling sites for Legionella study, Maritime Provinces
1983.

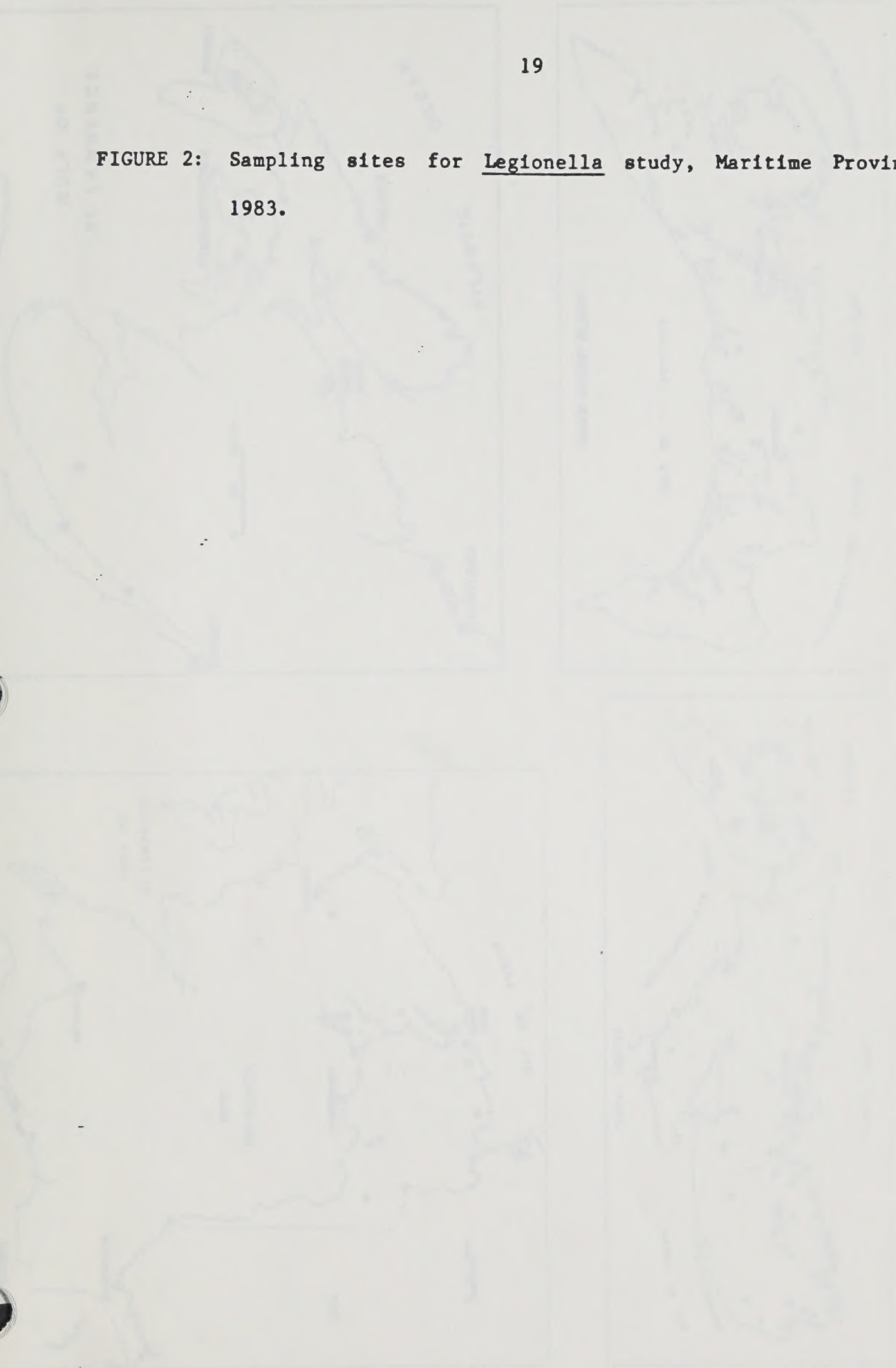


FIGURE 1: Graphical representation of the proposed model.

1997.

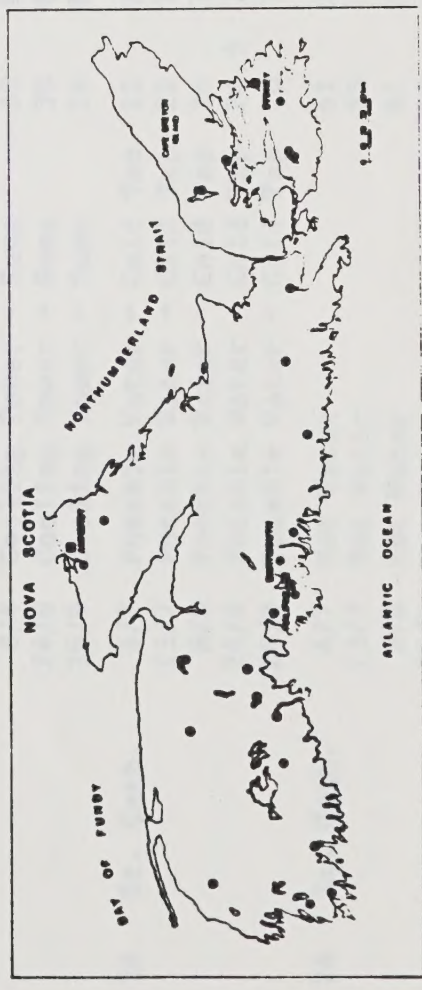
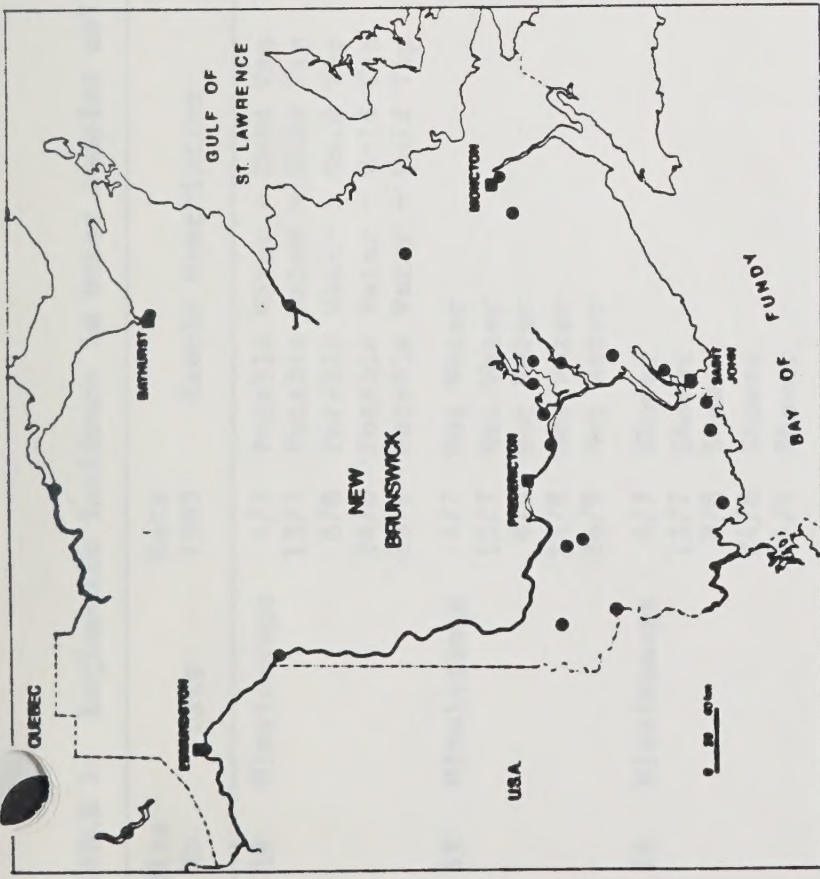
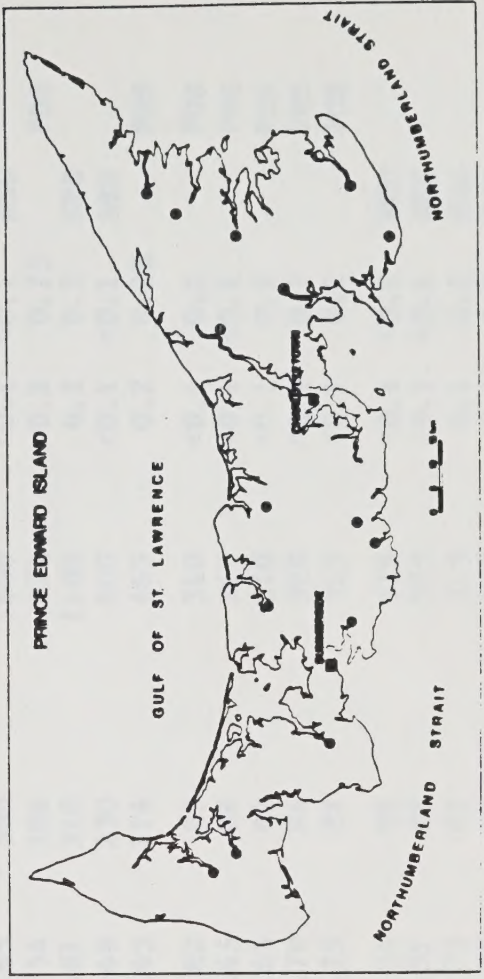
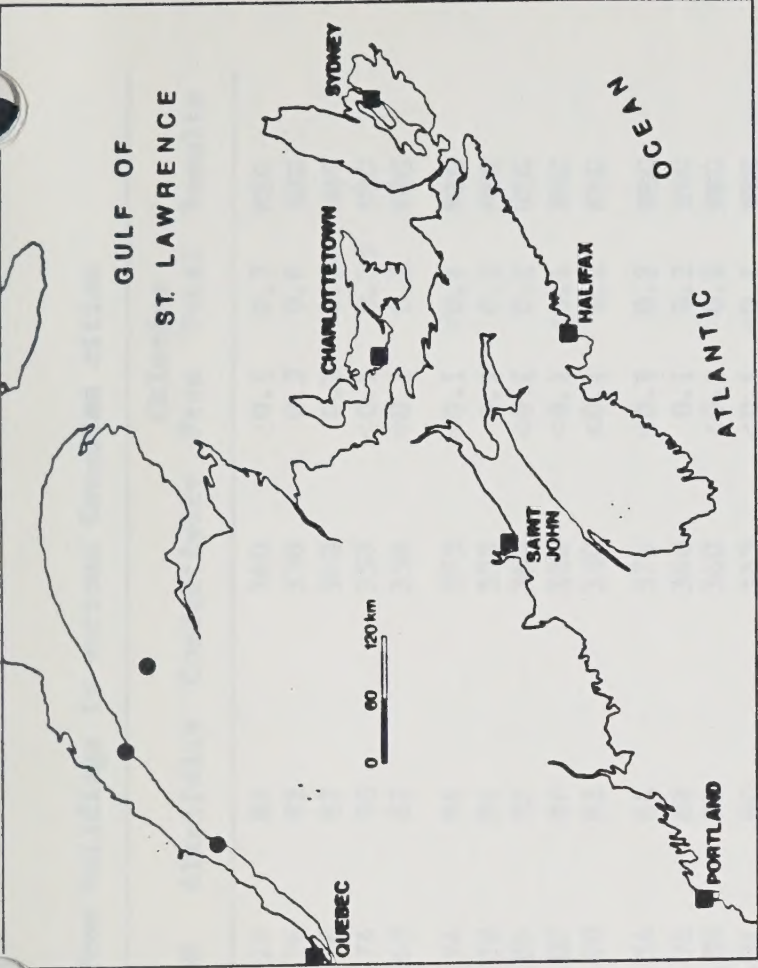




TABLE 1. Legionella incidence in water samples collected from buildings in various Canadian cities

Site No.	City	Date 1983	Sample Description	Temp. C	pH	Alkalinity	Conductivity	Chlorine		Results
								Free	Total	
1B	Mississauga	4/7	Potable Water - Cold Tap	13	7.24	84	340	<0.1	0.3	NEG
		13/7	Potable Water - Cold Tap	11	7.26	82	350	0.3	0.6	NEG
		8/8	Potable Water - Cold Tap	16	7.76	82	360	0.2	0.3	NEG
		24/8	Potable Water - Cold Tap	18	7.74	80	350	<0.1	0.25	NEG
		26/9	Potable Water - Cold Tap	15	7.65	82	350	<0.1	0.3	NEG
1B	Mississauga	4/7	Hot Water	65	7.24	84	375	<0.1	<0.1	NEG
		13/7	Hot Water	65	7.28	86	355	0.1	0.2	NEG
		8/8	Hot Water	61	7.86	82	360	<0.1	0.2	NEG
		24/8	Hot Water	62	8.02	80	350	<0.1	<0.1	NEG
		26/9	Hot Water	66	8.20	82	350	<0.1	0.2	NEG
1B	Mississauga	4/7	Shower	40	7.34	84	375	<0.1	0.2	NEG
		13/7	Shower	38	7.32	88	360	0.1	0.2	NEG
		8/8	Shower	42	7.88	82	360	<0.1	0.2	NEG
		24/8	Shower	42	8.01	80	335	<0.1	<0.1	NEG
		26/9	Shower	42	8.20	82	340	<0.1	0.25	NEG
1B	Mississauga	4/7	Cooling Tower - Sump	32	8.65	500	1800	<0.1	<0.1	NEG
		13/7	Cooling Tower - Sump	27	8.54	286	975	0.2	0.25	POS
		8/8	Cooling Tower - Sump	33	8.81	310	1100	0.2	0.3	NEG
		24/8	Cooling Tower - Sump	30	8.68	230	800	<0.1	<0.1	NEG
		26/9	Cooling Tower - Sump	24	8.65	114	465	0.2	0.25	POS
2A	St. Cath.	4/7	Potable Water - Cold Tap	22	7.82	82	310	<0.1	0.2	POS
		13/7	Potable Water - Cold Tap	22	7.45	88	310	<0.1	<0.1	POS
		8/8	Potable Water - Cold Tap	26	7.65	84	310	<0.1	0.2	POS
		24/8	Potable Water - Cold Tap	24.5	7.70	84	320	<0.1	0.2	POS
		26/9	Potable Water - Cold Tap	20	7.75	82	315	<0.1	0.2	POS
2A	St. Cath.	4/7	Hot Water	61	7.84	98	325	<0.1	<0.1	NEG
		13/7	Hot Water	60	7.51	88	325	<0.1	<0.1	NEG
		8/8	Hot Water	61	7.73	84	315	0.1	0.2	NEG
		24/8	Hot Water	60	7.85	84	310	0.1	0.2	NEG
		26/9	Hot Water	60	8.00	82	315	0.1	0.15	NEG

TABLE 1 (Cont'd) Legionella incidence in water samples collected from buildings in various Canadian cities

Site No.	City	Date 1983	Sample Description	Temp.		Alkalinity	Conductivity	Chlorine		Results
				C	pH			Free	Total	
2A	St. Cath.	4/7	Shower	41	7.73	88	325	<0.1	0.1	NEG
		13/7	Shower	40	7.61	88	310	<0.1	<0.1	POS
		8/8	Shower	42	7.71	84	315	<0.1	0.2	NEG
		24/8	Shower	42	7.70	84	310	<0.1	<0.1	NEG
		26/9	Shower	38	7.90	82	315	<0.1	0.15	NEG
2A	St. Cath.	4/7	Cooling Tower - Condenser Valve	31	8.92	580	1800	<0.1	<0.1	POS
		13/7	Cooling Tower - Condenser Valve	27	8.72	396	1250	6.0	6.5	POS
		8/8	Cooling Tower - Condenser Valve	32	8.94	560	1650	7.5	7.5	NEG
		24/8	Cooling Tower - Condenser Valve	28	8.62	385	1250	11.0	11.0	NEG
		26/9	Cooling Tower - Condenser Valve	26	8.90	290	930	7.5	7.5	NEG
3A	Ottawa	20/7	Potable Water	24	6.5	20	140	0.15	0.2	NEG
		20/7	Hot Water	51	6.5	20	150	0.15	0.2	NEG
		20/7	Shower	41	6.5	20	140	0.15	0.2	POS
		20/7	Cooling Tower	33	6.3	206	1100	0.15	0.2	NEG
3B	Ottawa	21/7	Potable Water	24	6.6	22	135	0.15	0.2	NEG
		21/7	Hot Water	52	6.5	22	150	0.1	0.2	NEG
		21/7	Shower	38	6.6	22	145	0.15	0.2	NEG
		21/7	Cooling Tower	24	6.5	142	1050	0.5	0.5	POS
3C	Ottawa	20/7	Potable Water	24	6.8	24	145	0.3	0.4	NEG
		20/7	Hot Water	52	6.8	22	150	0.15	0.2	NEG
		20/7	Shower	40	6.8	24	145	0.2	0.2	NEG
		20/7	Cooling Tower	29	6.8	42	260	0.15	0.2	POS
4A	Montreal	25/7	Potable Water	24	7.1	82	360	0.1	0.15	NEG
		25/7	Hot Water	52	7.2	82	375	0.1	0.15	NEG
		25/7	Shower	43	7.2	82	370	0.1	0.15	NEG
		25/7	Cooling Tower	33	7.9	242	950	0.6	0.6	NEG
4B	Montreal	26/7	Potable Water	24	7.5	82	350	0.3	0.4	NEG
		26/7	Hot Water	50	7.0	82	350	0.15	0.15	NEG
		26/7	Shower	41	7.6	82	350	0.2	0.2	NEG
		26/7	Cooling Tower	34	10.0	366	1160	<0.1	<0.1	NEG

Parameter	Source of variation	Sum of squares	D.F.	Mean square	F-value	Significance level
Yield (kg/ha)	Replication	1.20	1	1.20	0.05	ns
	Treatment	10.50	4	2.63	1.10	ns
	Error	18.30	16	1.14		
	Total	30.00	21			
Chlorophyll content (mg/g)	Replication	0.05	1	0.05	0.02	ns
	Treatment	0.40	4	0.10	0.40	ns
	Error	0.75	16	0.05		
	Total	1.20	21			
Stomatal conductance (mmol/m ² /s)	Replication	0.02	1	0.02	0.01	ns
	Treatment	0.15	4	0.04	0.15	ns
	Error	0.30	16	0.02		
	Total	0.47	21			
Transpiration rate (mmol/m ² /s)	Replication	0.01	1	0.01	0.00	ns
	Treatment	0.08	4	0.02	0.08	ns
	Error	0.15	16	0.01		
	Total	0.24	21			
Water use efficiency (kg/kg)	Replication	0.00	1	0.00	0.00	ns
	Treatment	0.05	4	0.01	0.05	ns
	Error	0.10	16	0.01		
	Total	0.15	21			

TABLE 1 (Cont'd) Legionella incidence in water samples collected from buildings in various Canadian cities

Site No.	City	Date 1983	Sample Description	Temp.		pH	Alkalinity	Conductivity	Chlorine		Results
				C	F				Free	Total	
4C	Montreal	25/7	Potable Water	17	7.5	82		350	0.1	0.1	NEG
		25/7	Hot Water	62	7.8	82		350	0.1	0.1	NEG
		25/7	Shower	42	7.8	82		350	0.1	0.15	NEG
		25/7	Cooling Tower	32	8.2	244		1000	0.6	0.7	NEG
5A	Quebec	23/7	Potable Water	30	7.0	58		300	0.15	0.2	NEG
		23/7	Hot Water	58	7.1	58		320	0.15	0.15	NEG
		23/7	Shower	37	7.0	58		310	0.15	0.2	NEG
		23/7	Cooling Tower	28	6.9	72		1160	1.1	1.2	NEG
5B	Quebec	24/7	Potable Water	24	7.2	22		190	0.15	0.2	NEG
		24/7	Hot Water	56	7.2	22		190	0.15	0.2	NEG
		24/7	Shower	33	7.4	22		190	0.15	0.15	NEG
		24/7	Cooling Tower	26	6.4	92		920	0.5	0.5	NEG
5C	Quebec	23/7	Potable Water	24	6.7	66		330	0.2	0.2	NEG
		23/7	Hot Water	48	6.5	66		325	0.15	0.15	NEG
		23/7	Shower	39	6.8	66		330	0.15	0.15	NEG
		23/7	Cooling Tower	26	8.0	290		1320	0.6	0.6	NEG
6A	Fredericton	10/8	Potable Water	21	6.8	56		220	<0.1	<0.1	NEG
		10/8	Hot Water	43	6.8	56		275	<0.1	<0.1	NEG
		10/8	Shower	32	6.8	56		230	<0.1	<0.1	NEG
		10/8	Cooling Tower	33	8.6	270		1000	0.6	0.6	NEG
6B	Fredericton	10/8	Potable Water	13	7.0	56		200	<0.1	<0.1	NEG
		10/8	Hot Water	65	6.9	56		280	<0.1	<0.1	NEG
		10/8	Shower	38	6.9	56		250	<0.1	<0.1	NEG
		10/8	Cooling Tower	25	8.6	232		900	0.5	0.5	NEG
6C	Fredericton	10/8	Potable Water	11	6.5	56		180	<0.1	<0.1	NEG
		10/8	Hot Water	48	6.7	56		275	<0.1	<0.1	NEG
		10/8	Shower	34	6.8	56		250	<0.1	<0.1	NEG
		10/8	Cooling Tower	29	8.2	430		1750	0.4	0.4	NEG

NO	CLAD	1983 DATA	number Dents/Inches	C mm	in	WIPPLE mm	Depth mm	1983 DATA	1982 DATA	1981 DATA
22	Laminated	1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	Laminated	1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	Laminated	1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	Grip	1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	Grip	1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
27	Grip	1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28	Grip	1983	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1987	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 1 (Cont'd) Performance of various materials in various applications in various environments

TABLE 1 (Cont'd) Legionella incidence in water samples collected from buildings in various Canadian cities

Site No.	City	Date 1983	Sample Description	Temp. C	pH	Alkalinity	Conductivity	Chlorine		Results
								Free	Total	
7A	Halifax	15/8	Potable Water	21	8.9	14	100	<0.1	4.0	NEG
		15/8	Hot Water	65	8.5	14	150	<0.1	4.0	NEG
		15/8	Shower	49	8.8	14	125	<0.1	4.0	NEG
		15/8	Drinking Fountain	19	8.9	14	100	<0.1	4.0	NEG
7B	Halifax	15/8	Potable Water	24	7.9	32	150	<0.1	<0.1	NEG
		15/8	Hot Water	58	8.0	32	150	<0.1	<0.1	NEG
		15/8	Shower	32	8.0	32	170	<0.1	<0.1	NEG
		15/8	Cooling Tower	23	8.3	330	7000	0.7	0.8	POS
7C	Halifax	15/8	Potable Water	20	8.0	32	175	0.1	0.2	NEG
		15/8	Hot Water	80	7.5	32	200	0.1	<0.1	NEG
		15/8	Shower	33	7.8	32	175	0.1	<0.1	NEG
		15/8	Cooling Tower	30	8.1	170	600	0.8	1.0	NEG
8A	Winnipeg	19/9	Potable Water	18	7.2	60	180	0.3	0.5	NEG
		19/9	Hot Water	55	7.3	60	180	<0.1	0.2	NEG
		19/9	Shower	42	7.4	60	180	0.2	0.3	NEG
		19/9	Cooling Tower	22	7.6	44	1075	0.1	0.4	NEG
8B	Winnipeg	19/9	Potable Water	20	7.4	62	175	0.25	0.5	NEG
		19/9	Hot Water	51	7.4	62	175	<0.1	0.25	NEG
		19/9	Shower	38	7.4	62	175	0.15	0.25	NEG
		19/9	Cooling Tower	15	8.5	164	410	0.2	0.2	NEG
8C	Winnipeg	19/9	Potable Water	18	7.2	62	180	0.25	0.4	NEG
		19/9	Hot Water	67	7.4	62	180	0.1	<0.1	NEG
		19/9	Shower	42	7.4	62	180	0.2	0.25	NEG
		19/9	Drinking Fountain	13	7.2	62	180	0.3	0.4	NEG

TABLE 1 (Cont'd) Legionella incidence in water samples collected from buildings in various Canadian cities

Site No.	City	Date 1983	Sample Description	Temp.		pH	Alkalinity	Conductivity	Chlorine		Results
				C	F				Free	Total	
9A	Regina	12/9	Potable Water	13	7.1	276	1130	<0.1	<0.1	<0.1	NEG
		12/9	Hot Water	62	7.2	281	1050	<0.1	<0.1	<0.1	NEG
		12/9	Shower	40	7.5	280	1050	<0.1	<0.1	<0.1	POS
		12/9	Cooling Tower	26	8.9	630	2800	<0.1	<0.1	<0.1	NEG
9B	Regina	12/9	Potable Water	14	7.4	290	1350	<0.1	<0.1	<0.1	NEG
		12/9	Hot Water	67	7.4	295	1200	<0.1	<0.1	<0.1	NEG
		12/9	Shower	41	7.4	290	1350	<0.1	<0.1	<0.1	NEG
		12/9	Cooling Tower	19	8.35	312	3950	<0.1	<0.1	<0.1	NEG
9C	Regina	12/9	Potable Water	16	7.2	220	970	0.1	0.2	0.2	NEG
		12/9	Hot Water	50	7.4	220	1050	<0.1	<0.1	<0.1	NEG
		12/9	Shower	36	7.5	220	1050	<0.1	<0.1	<0.1	NEG
		12/9	Cooling Tower	19	8.05	150	4400	0.2	0.25	0.25	NEG
9D	Poplar River	17/9	Potable Water	15	8.4	630	1500	1.0	1.4	1.4	NEG
		17/9	Hot Water	59	8.4	640	1500	<0.1	<0.2	<0.2	NEG
		17/9	Shower	46	8.6	630	1500	<0.1	<0.2	<0.2	NEG
		17/9	Drinking Fountain	11	8.4	630	1500	3.6	0.7	0.7	NEG
10A	Calgary	31/8	Potable Water	18	8.0	98	270	<0.1	0.3	0.3	NEG
		31/8	Hot Water	55	8.2	98	320	<0.1	0.2	0.2	NEG
		31/8	Shower	34	8.1	98	270	<0.1	0.3	0.3	NEG
		31/8	Cooling Tower	25	8.6	432	1850	<0.1	<0.1	<0.1	NEG
10B*	Calgary	31/8	Potable Water	21	8.2	98	280	<0.1	0.25	0.25	NEG
		31/8	Hot Water	70	8.4	96	310	<0.1	<0.1	<0.1	NEG
		31/8	Shower	32	8.2	98	275	<0.1	0.1	0.1	NEG
		31/8	Cooling Condenser (Heat exchanger)	28	8.4	100	275	<0.1	<0.1	<0.1	POS
10C*	Calgary	31/8	Potable Water	20	7.9	98	320	<0.1	0.2	0.2	NEG
		31/8	Hot Water	41	7.9	100	340	<0.1	0.2	0.2	NEG
		31/8	Shower	35	7.9	98	340	<0.1	0.2	0.2	NEG
		31/8	Cooling Tower	25	8.5	424	900	<0.1	<0.1	<0.1	POS

TABLE 1. Legionella incidence in water samples collected from buildings in various Canadian cities

Site No.	City	Date 1983	Sample Description	Temp.		pH	Alkalinity	Conductivity	Chlorine		Results
				C	F				Free	Total	
11A	Edmonton	2/9	Potable Water	20	7.6	96		330	<0.1	2.5	NEG
		2/9	Hot Water	52	7.6	96		325	<0.1	2.0	NEG
		2/9	Air Washer (Scrubber)	10	8.0	86		300	<0.1	<0.1	NEG
		2/9	Cooling Tower	21	8.7	316		800	<0.1	<0.1	NEG
11B	Edmonton	2/9	Potable Water	19	7.6	94		320	<0.1	2.0	NEG
		2/9	Hot Water	59	7.6	94		340	<0.1	1.5	NEG
		2/9	Shower	36	7.6	94		325	<0.1	2.0	NEG
		2/9	Cooling Tower	21	8.3	380		1300	<0.1	<0.1	NEG
11C	Edmonton	2/9	Potable Water	19	7.8	96		310	<0.1	2.0	NEG
		2/9	Hot Water	58	7.9	96		320	<0.1	2.0	NEG
		2/9	Shower	37	7.8	96		310	<0.1	2.0	NEG
		2/9	Cooling Tower (Heat Exchanger)	25	8.2	112		325	<0.1	<0.1	NEG
12A	Vancouver	6/9	Potable Water	16	6.7	3		25	<0.1	<0.1	NEG
		6/9	Hot Water	52	6.7	3		26	<0.1	<0.1	NEG
		6/9	Shower	29	6.7	3		26	<0.1	<0.1	NEG
		6/9	Cooling Tower	25	8.6	180		350	<0.1	<0.1	NEG
12C	Vancouver	6/9	Potable Water	18	6.5	4		26	<0.1	<0.1	NEG
		6/9	Hot Water	55	6.3	4		26	<0.1	<0.1	NEG
		6/9	Shower	34	6.4	4		26	<0.1	<0.1	NEG
		6/9	Cooling Tower	15	6.3	4		28	<0.1	<0.1	POS

All analyses are expressed as mg/L except conductivity which is in micromhos/cm

TABLE 2. Microbiological data, selected stations, Maritime Provinces

Sampling Site	Province	Heterotrophic Plate Count /mL	Stteptomycetes /100 mL	Total Count /mL	INT Formazan Reducing Bacteria /mL	% INT of Total Count
Rivier-du-loup St. Lawrence River	Que	34,000	130	5.5×10^6	1.9×10^5	3.4
Edmundston St. John River	NB	40,000	30	4.6×10^6	9.4×10^5	20.4
Maugerville St. John River	NB	7,400	30	6.7×10^6	2.1×10^5	3.1
Bellefleur Bay	NB	5,800	40	2.6×10^6	1.9×10^5	7.3
Spruce Lake	NB	1,000	4	9.7×10^6	3.3×10^5	3.4
Wentworth Lake	NS	600	10	3.5×10^6	$< 2.4 \times 10^4$	0.6
Waterloo Lake	NS	1,340	10	3.7×10^6	4.7×10^4	1.3
Keamey Lake	NS	500	<2	2.4×10^6	1.2×10^5	5.0
Banook Lake	NS	5,400	10	2.0×10^6	9.5×10^4	4.7
East Sheet River	NS	7,200	80	4.4×10^6	2.4×10^4	0.5
Guysborough R.	NS	1,640	80	3.4×10^6	2.6×10^5	7.6
Ainslie Lake	NS	800	24	1.8×10^6	4.7×10^4	2.6
Harrison Lake	NS	980	102	3.9×10^6	9.5×10^4	2.4
Pisquid River	PEI	380	220	3.4×10^6	1.7×10^5	5.0
Avondale Lake	PEI	2,180	120	7.6×10^6	1.4×10^6	18.4
McAusland Pond	PEI	44,800	80	2.8×10^6	4.0×10^5	14.2
Moncton Centennial Park Pond	NB	3,600	15	6.7×10^6	1.4×10^5	2.1
Richibucto River	NB	1,300	80	1.7×10^6	3.6×10^4	2.1
Restigouche River	NB	22,600	12	2.6×10^6	2.1×10^5	8.1

TABLE 3. Summary of positive isolations and concentrations of Legionella organisms in the cross-Canada survey of waters collected from building water distribution lines and cooling towers

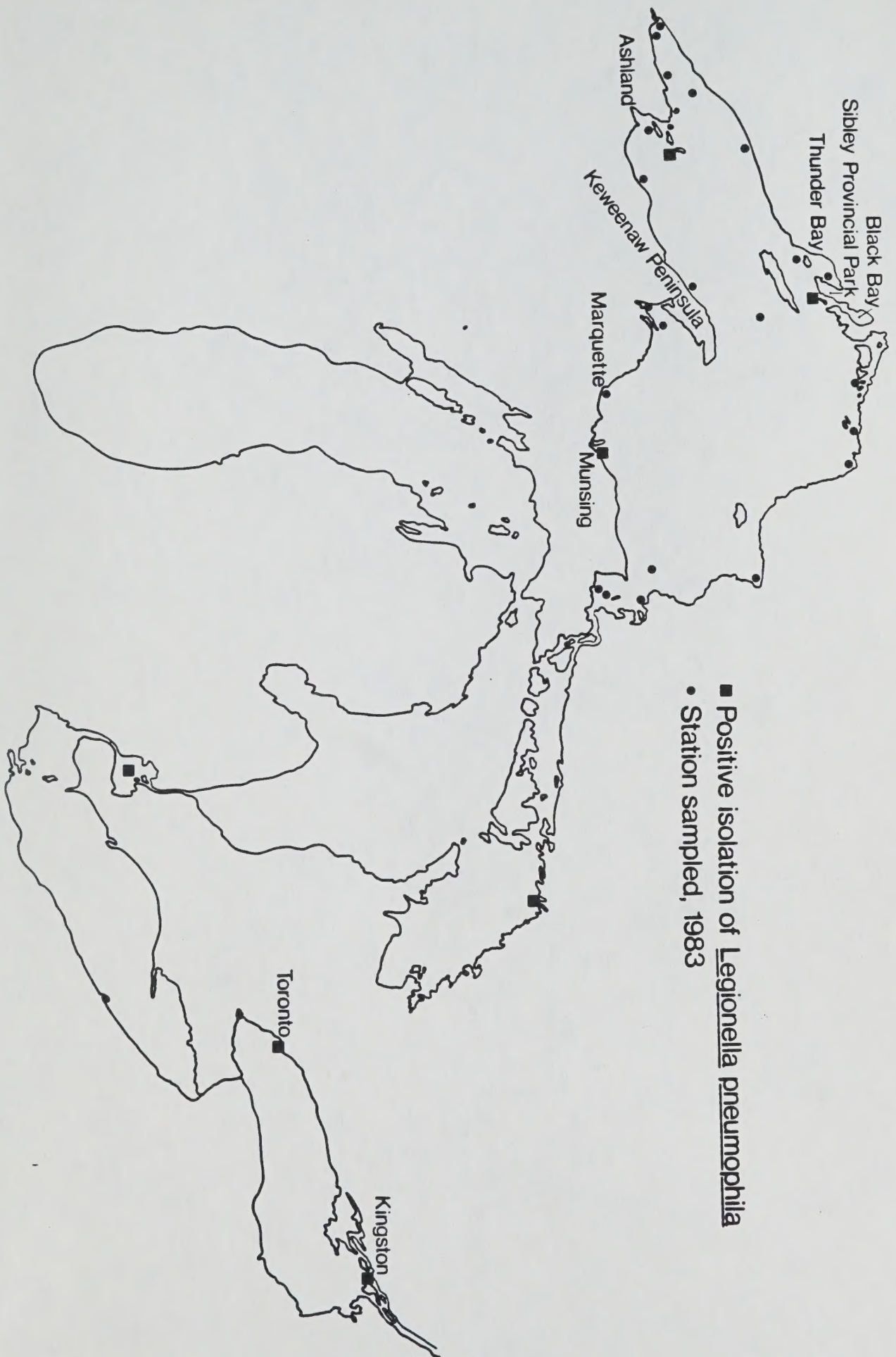
Sampling Site	Sample	Organism	Media and Concentration of Legionella			
			CCVC	CCVC-	CCVC+	GVP
Mississauga	Cooling tower	<u>L. pneumophila</u> Serogroup 6	0	0	0	90/L
Mississauga	Cooling tower	<u>L. pneumophila</u> Serogroup 6	780/L	0	660/L	990/L
St. Catharines	Cold water tap	<u>L. pneumophila</u> Serogroup 1	0	0	210/L	0
St. Catharines	Cold water tap	<u>L. pneumophila</u> Serogroup 1	120/L	0	30/L	0
St. Catharines	Cold water tap	<u>L. pneumophila</u> Serogroup 1	180/L	0	0	0
St. Catharines	Cold water tap	<u>L. pneumophila</u> Serogroup 1	0	90/L	90/L	0
St. Catharines	Cold water tap	<u>L. pneumophila</u> Serogroup 1	0	0	30/L	0
St. Catharines	Shower	<u>L. pneumophila</u> Serogroup 1	0	0	30/L	0
St. Catharines	Cooling tower	<u>L. pneumophila</u> Serogroup 1	0	0	0	360/L
St. Catharines	Cooling tower	<u>L. pneumophila</u> Serogroup 1	0	0	0	60/L
St. Catharines	Cooling tower	<u>L. pneumophila</u> Serogroup 1	45,000/L	24,000/L	45,000/L	45,000/L
Ottawa 3A	Shower	<u>L. pneumophila</u> Serogroup 3	0	0	0	210/L
Ottawa 3B	Cooling tower	<u>L. pneumophila</u> Serogroup 1	0	0	30/L	0
Ottawa 3C	Cooling tower	<u>L. pneumophila</u> Serogroup 1	0	0	0	60/L
Montreal 4A	Cooling tower	<u>L. pneumophila</u> Serogroup 6	9,000/L	15,000/L	9,000/L	15,000/L
Halifax 7B	Cooling tower	<u>L. pneumophila</u> Serogroup 6	900/L	2,550/L	1,200/L	2,010/L
Regina 9A	Shower	<u>L. pneumophila</u> Serogroup 6	0	0	1,290/L	270/L
Calgary 10B	Cooling condenser	<u>L. pneumophila</u> Serogroup 4	0/L	0	0	9,000/L
Calgary 10C	Cooling tower	<u>Legionella</u> species <i>Sewer group</i> (COC for confirmation)	6,000/L	0	0	300/L
Vancouver 12C	Cooling tower	<u>L. pneumophila</u> Serogroup 6	0	0	0	
Total positive isolations by media			7	4	11	12

TABLE 4. Antibiotic sensitivity patterns of *Legionella* isolates

TABLE 4. Antibiotic sensitivity patterns of <i>Legionella</i>											
Source	Legionella Species	Antibiotic Sensitivity Pattern - Radius of Inhibition in mm							Colistin Sulphate		
		Penicillin G 10 µg	Cefoxitin 30 µg	Clindamycin 10 µg	Vancomycin 30 µg	Tetracycline 30 µg	Ampicillin 10 µg	Erythromycin 15 µg			
St. Catharines	Cooling tower	9	21	4	2	3	12	19	R		
St. Catharines	Cooling tower	9	24	8	2.5	4	15	19	R		
St. Catharines	Cold water - Potable	11	23	9	4	5.5	13	20	R		
St. Catharines	Cooling tower	9	26	5.5	5	5	13	18	R		
St. Catharines	Cold water - Potable	9	23	3	2	4	12	18	R		
St. Catharines	Shower	6	17	8	4	5	12	18	R		
St. Catharines	Cold water - Potable	3	19	R	3	3	11	17	R		
St. Catharines	Cold water - Potable	7	15	5	5	2	9	16	R		
St. Catharines	Cold water - Potable	9	24	4	5	2.5	12	21	R		
Mississauga	Cooling tower	7	20	7	8	3	12	19	R		
Mississauga	Cooling tower - A(2) B(2)	R	21	5	6	3	11	21	R		
Ottawa 3A	Shower	12	21	2.5	3	5	15	16	R		
Ottawa 3B		8	23	11	3	6	15	22	R		
Ottawa 3C	Cooling tower	16	24	5	6	5	15	21	R		
Ottawa 4A	Cooling tower	11	24	4	3	5	16	25	R		
Halifax 7B	Cooling tower	9	14	8	7	4	9	11	R		
Regina 9A	Shower	11	19	10	4	8	15	24	R		
		3	19	10	5	8	5	19	R		
		R	16	6	5	6	2	19	R		
		R	15	3	5	2	3	18	R		
Calgary 10B	Cooling Condenser	11	26	3	4	5	16	25	R		
Calgary 10C		3	19	3	3	2	7.5	16	R		
Vancouver 12C	Cooling tower	6	17	5	6	3	10	18	R		
Lake Superior	Station 50	R	18	R	4	4	5	18	R		
Lake Superior	Station 135	6	16	3	5.5	4	8	18	R		

(1) Atypical species sent to CDC for confirmation.

A(2), B(2) Colony morphology different.





distances shown to nearest inch
Color indicates nature

